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Abstract: **BACKGROUND** Abdominal infections are frequent causes of sepsis and septic shock in the intensive care unit (ICU) and are associated with adverse outcomes. We analyzed the characteristics, treatments and outcome of ICU patients with abdominal infections using data extracted from a one-day point prevalence study, the Extended Prevalence of Infection in the ICU (EPIC) II. **METHODS** EPIC II included 13,796 adult patients from 1,265 ICUs in 75 countries. Infection was defined using the International Sepsis Forum criteria. Microbiological analyses were performed locally. Participating ICUs provided patient follow-up until hospital discharge or for 60 days. **RESULTS** Of the 7,087 infected patients, 1,392 (19.6%) had an abdominal infection on the study day (60% male, mean age 62 ± 16 years, SAPS II score 39 ± 16 , SOFA score 7.6 ± 4.6). Microbiological cultures were positive in 931 (67%) patients, most commonly Gram-negative bacteria (48.0%). Antibiotics were administered to 1366 (98.1%) patients. Patients who had been in the ICU for ≥ 2 days prior to the study day had more *Escherichia coli*, methicillin-sensitive *Staphylococcus aureus* and anaerobic isolates, and fewer enterococci than patients who had been in the ICU longer. ICU and hospital mortality rates were 29.4% and 36.3%, respectively. ICU mortality was higher in patients with abdominal infections than in those with other infections (29.4% vs. 24.4%, $p < 0.001$). In multivariable analysis, hematological malignancy, mechanical ventilation, cirrhosis, need for renal replacement therapy and SAPS II score were independently associated with increased mortality. **CONCLUSIONS** The characteristics, microbiology and antibiotic treatment of abdominal infections in critically ill patients are diverse. Mortality in patients with isolated abdominal infections was higher than in those who had other infections.

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RESEARCH ARTICLE

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Abdominal infections in the intensive care unit: characteristics, treatment and determinants of outcome

Jan De Waele^{1*}, Jeffrey Lipman², Yasser Sakr³, John C Marshall⁴, Philippe Vanhems⁵, Casiano Barrera Groba⁶, Marc Leone⁷, Jean-Louis Vincent⁸ and for the EPIC II Investigators

Abstract

Background: Abdominal infections are frequent causes of sepsis and septic shock in the intensive care unit (ICU) and are associated with adverse outcomes. We analyzed the characteristics, treatments and outcome of ICU patients with abdominal infections using data extracted from a one-day point prevalence study, the Extended Prevalence of Infection in the ICU (EPIC) II.

Methods: EPIC II included 13,796 adult patients from 1,265 ICUs in 75 countries. Infection was defined using the International Sepsis Forum criteria. Microbiological analyses were performed locally. Participating ICUs provided patient follow-up until hospital discharge or for 60 days.

Results: Of the 7,087 infected patients, 1,392 (19.6%) had an abdominal infection on the study day (60% male, mean age 62 ± 16 years, SAPS II score 39 ± 16 , SOFA score 7.6 ± 4.6). Microbiological cultures were positive in 931 (67%) patients, most commonly Gram-negative bacteria (48.0%). Antibiotics were administered to 1366 (98.1%) patients. Patients who had been in the ICU for ≤ 2 days prior to the study day had more *Escherichia coli*, methicillin-sensitive *Staphylococcus aureus* and anaerobic isolates, and fewer enterococci than patients who had been in the ICU longer. ICU and hospital mortality rates were 29.4% and 36.3%, respectively. ICU mortality was higher in patients with abdominal infections than in those with other infections (29.4% vs. 24.4%, $p < 0.001$). In multivariable analysis, hematological malignancy, mechanical ventilation, cirrhosis, need for renal replacement therapy and SAPS II score were independently associated with increased mortality.

Conclusions: The characteristics, microbiology and antibiotic treatment of abdominal infections in critically ill patients are diverse. Mortality in patients with isolated abdominal infections was higher than in those who had other infections.

Keywords: Abdominal infection, Abscess, Peritonitis, Severe sepsis, Critical care, Antibiotic therapy, Microbiology

Background

Abdominal infection is a common indication for admission to the intensive care unit (ICU) and the abdomen is the second most common site of invasive infection among critically ill patients in epidemiological [1-3] and therapeutic [4] studies. Abdominal infections are more often associated with septic shock and acute kidney injury than are infections in other sites [5,6]. The spectrum of

disease and severity is broad and management of these infections is challenging [7-9].

Multicenter data on the clinical features and microbiology of abdominal infections in the critically ill are rare, and often limited to a single region or country. In recent years, an increase in abdominal infections due to nosocomial and resistant organisms has been reported [10-14], but large-scale data are lacking. Although outcomes may have improved over the years [15], abdominal infections still carry a significant mortality risk. Isolation of nosocomial microorganisms [16], enterococci [17] or fungi [18,19] is often cited as contributing

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to mortality, but the extent to which these organisms contribute to that risk is unknown. The role of comorbidities as well as demographic characteristics has also not been studied on a large scale. Prolonged stay in a critical care environment may be associated with changes in microbiology, thus affecting empirical antibiotic treatment, yet recent guidelines do not include length of stay as a potential surrogate marker for the presence of nosocomial or less susceptible microorganisms [20].

The Extended Prevalence of Infection in the ICU (EPIC) II study was a large one-day point-prevalence study of infections in the ICU. The study showed that half of all ICU patients were infected on the study day and 71% were being treated with antibiotics [1]. We used the data collected in the EPIC II study to (1) analyze the characteristics of abdominal infections (patient characteristics, micro-organisms) as well as the antibiotics used to treat these infections; (2) explore the differences in microbiology according to the length of stay in the ICU; and (3) identify clinical and microbiological factors associated with mortality.

Methods

The EPIC II study was performed on May 8, 2007. Demographic, physiological, bacteriological and therapeutic data were collected from 13,796 adult (>18 years) patients in 1,265 participating ICUs from 75 countries (see Appendix for list of participating centers) on the study day as previously described [1]. The EPIC II study was approved by the Erasme Hospital ethics committee. Local ethical committee approval at each participating center was expedited or waived because of the purely observational nature of the study. Infection was defined according to the criteria of the International Sepsis Forum (ISF) [21] and classified by the attending physician. Microbiological analyses were performed locally. Participating ICUs were asked to provide patient follow-up until hospital discharge or for 60 days.

For the purposes of this study, we analyzed data from the patients who were diagnosed with an intra-abdominal infection.

Statistics

Statistical analyses were performed using PASW Statistics 18 for windows (SPSS Inc., Chicago, USA). Data are presented as mean (\pm standard deviation [SD]), median (interquartile range [IQR]), or number (%) as appropriate. To identify factors associated with mortality, a multivariable logistic regression model (single step, forced entry) was constructed using variables for which the P-value was <0.1 in univariable analysis. Goodness of fit was assessed by the Hosmer-Lemeshow statistic. All tests were two-tailed, and a $P < 0.05$ was considered statistically significant.

Results

Of the 7,087 infected patients, 1,392 (19.6%) were diagnosed as having an abdominal infection on the study day (Table 1). Cancer and chronic obstructive pulmonary disease (COPD) were the most frequent comorbidities. The majority of the patients (885 [63.7%]) had undergone emergency surgery. Other concomitant infections were frequently present, with respiratory infections and bloodstream infections occurring in 26.8% and 11.6% of the patients, respectively (Additional file 1: Table S1).

Table 1 Patient characteristics

Age, mean \pm SD, year	62 \pm 16
Male, n (%)	831 (60)
SAPS II score, mean \pm SD	38.9 \pm 16.4
SOFA score, mean \pm SD	7.6 \pm 4.6
Length of ICU stay before May 8, median (IQR), days	6 (1–15)
Type of admission, n (%)	
Surgical - emergency	885 (63.7)
Medical	260 (18.7)
Surgical - elective	198 (14.2)
Trauma	47 (3.4)
Admission source, n (%)	
OR/recovery room	488 (35.3)
Hospital floor	465 (33.6)
ER/ambulance	199 (14.4)
Other hospital	194 (14.0)
Other	36 (2.6)
Comorbidities, n (%)	
Cancer	321 (23.1)
COPD	225 (16.2)
Chronic renal failure	140 (10.1)
Insulin dependent diabetes mellitus	131 (9.4)
Heart failure (NYHA III-IV)	107 (7.7)
Cirrhosis	79 (5.7)
Hematological cancer	24 (1.7)
HIV	12 (0.9)
Organ support on the study day	
Mechanical ventilation	863 (62.0)
Renal replacement therapy	220 (15.8)
Outcome measures	
ICU LOS, median (IQR), days	16 (6–34)
Hospital LOS, median (IQR), days	30 (14–59)
ICU mortality, n (%)	382 (29.4)
Hospital mortality, n (%)	472 (36.3)

SAPS II = Simplified Acute Physiology Score II; SOFA = Sequential Organ Failure Assessment; HIV = Human Immunodeficiency Virus; NYHA III-IV = New York Heart Association class III-IV.

Microbiological data were available for 931 patients (67%), with a total of 1,289 microorganisms isolated (Table 2). Polymicrobial infections were present in 40.1% of the patients. *Escherichia coli* was isolated most frequently, with *Pseudomonas* spp. and *Klebsiella* spp. ranking second and third among the Gram-negative isolates. *Enterococcus* was the most prevalent Gram-positive isolate. Antibiotic resistance was relatively rare: ampicillin-resistant enterococci were isolated in 70 patients (7.5%), methicillin-resistant staphylococci in 59 patients (6.3%). *Candida* species were isolated in 156 patients (16.8%), 75.6% of these isolates were *Candida albicans*.

Almost all the patients with abdominal infections (98.1%) were receiving antibiotics: penicillins and other beta-lactam antibiotics (excluding cephalosporins) were used most frequently (38.6% and 34.4% of the patients, respectively) (Additional file 1: Table S2); 29.4% of the patients were receiving antifungal agents.

ICU (median 16 [IQR 6–34] days vs. 17 [7–34] days, $P = 0.07$) and hospital (30 [14–59] days vs. 29 [14–56] days, $P = 0.68$) lengths of stay (LOS) were similar in patients with abdominal infections and those with other infections. Overall ICU and hospital mortality rates were 29.4% and 36.3%, respectively (Table 1). Mortality rates were higher in patients who had abdominal infections than in patients from the EPIC II cohort who had other infections (ICU mortality 29.4% vs. 24.4%, $P < 0.001$, and hospital mortality 36.3% vs. 32.3%, $P = 0.005$). ICU and hospital mortality rates in non-infected patients in the EPIC-II cohort were 10.7% and 14.8%, respectively.

Non-survivors were older, had higher SAPS II and SOFA scores on the study day, and were more likely to have cirrhosis, heart failure, or hematological cancer. They were also more likely to be receiving mechanical ventilation or renal replacement than survivors (Table 3). Survivors and non-survivors had similar patterns of infecting organisms, except for *P. aeruginosa* and *Stenotrophomonas maltophilia*, which were isolated more frequently in non-survivors than in survivors (Additional file 1: Table S3). In multivariable analysis, hematological cancer, mechanical ventilation, cirrhosis, renal replacement therapy and SAPS II score on the study day were independently associated with increased mortality (Table 4).

In patients who had been in the ICU for 2 days or less prior to the study day, there were more *E. coli*, methicillin-sensitive *S. aureus* and anaerobic isolates and fewer enterococci than in patients who had been in the ICU for a longer period of time; there was also a trend towards fewer *P. aeruginosa*, *Citrobacter* spp. and *C. albicans* isolates (Table 5).

Discussion

This study is one of the first to look at abdominal infections in critically ill patients from a global perspective.

Table 2 A total of 1289 micro-organisms were recovered from the 931 patients with abdominal infections and positive cultures

	n (%)
Gram-negative bacteria	619 (48.0%)
<i>Escherichia coli</i>	211
<i>Pseudomonas aeruginosa</i>	86
<i>Klebsiella</i> spp.	85
<i>Enterobacter</i> spp.	77
<i>Proteus</i> spp.	47
<i>Acinetobacter</i> spp.	35
<i>Stenotrophomonas maltophilia</i>	17
<i>Citrobacter</i> spp.	13
<i>Bacillus</i>	13
Enterobacteria, other	9
<i>Campylobacter</i> spp.	7
<i>Salmonella</i> spp.	7
<i>Serratia</i> spp.	6
<i>Pseudomonas</i> , other than <i>P. aeruginosa</i>	4
<i>Haemophilus</i> spp.	2
Gram-positive bacteria	366 (28.4%)
Enterococci, ampicillin-sensitive	122
Enterococci, ampicillin-resistant	70
Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)	34
Methicillin-sensitive coagulase-negative staphylococci	27
<i>Streptococcus</i> , other than group A, B, C and D	31
Methicillin-resistant coagulase-negative staphylococci	25
Methicillin-sensitive <i>S. aureus</i>	21
Group A, B, C, G <i>Streptococcus</i>	15
Gram-positive cocci, other	8
Gram-positive bacilli, other	8
<i>Streptococcus pneumoniae</i>	5
Anaerobes	146 (11.3%)
<i>Clostridium</i>	94
<i>Bacteroides</i>	29
Anaerobes, other	16
Anaerobic cocci	7
Fungi	130 (10.1%)
<i>Candida albicans</i>	118
<i>Candida</i> non-albicans	38
Fungi, other	5
<i>Aspergillus</i> spp.	2
Viruses	12 (0.9%)
Other	16 (1.2%)

Table 3 Characteristics of survivors and non-survivors

	Survivors (n = 917)	Non-survivors (n = 382)	p
Age, mean \pm SD	61.6 \pm 16.5	65.2 \pm 14.9	<0.001
Male, n (%)	546 (59.7)	223 (58.5)	0.7
Severity score on study day			
SAPS II, mean \pm SD	34.2 \pm 13.5	50.1 \pm 17	<0.001
SOFA, mean \pm SD	6.2 \pm 3.8	10.5 \pm 4.6	<0.001
ICU stay before May 8, median (IQR)	5 (1–13)	8 (1–18)	<0.001
Type of admission, n (%)			
			0.58
Surgical/elective	124 (13.5)	62 (16.3)	
Medical	179 (19.5)	69 (18.2)	
Surgical/emergency	580 (63.2)	237 (62.4)	
Trauma	34 (3.7)	12 (3.2)	
Admission source, n (%)			
			0.12
OR/recovery room	349 (38.2)	120 (31.7)	
Hospital floor	290 (31.8)	141 (37.2)	
ER/ambulance	135 (14.8)	50 (13.2)	
Other hospital	116 (12.7)	57 (15)	
Other	23 (2.5)	11 (2.9)	
Comorbidities, n (%)			
COPD	149 (16.2)	62 (16.2)	0.99
Cancer	203 (22.1)	97 (25.4)	0.20
Heart failure (NYHA III-IV)	62 (6.8)	40 (10.5)	0.02
Insulin dependent diabetes mellitus	87 (9.5)	37 (9.7)	0.91
Chronic renal failure	83 (9.1)	44 (11.5)	0.17
Cirrhosis	39 (4.3)	33 (8.6)	<0.01
Hematological cancer	9 (1.0)	14 (3.7)	<0.001
HIV	6 (0.7)	6 (1.6)	0.12
Treatment on the study day, n (%)			
Mechanical ventilation	534 (58.2)	329 (86.4)	<0.001
RRT (hemodialysis or hemofiltration)	110 (12.0)	110 (28.9)	<0.001
Outcome			
ICU LOS, median (IQR)	14 (5–32)	18 (9–38)	<0.001
Other sites of infection, n (%)			
Respiratory	221 (24.1)	120 (31.4)	<0.01
Blood stream	97 (10.6)	56 (14.7)	0.04
Renal/urinary tract	53 (5.8)	33 (8.6)	0.06
Skin	29 (3.2)	23 (6)	0.02
Catheter-related	28 (3.1)	21 (5.5)	0.04
CNS	1 (0.1)	0 (0)	0.52
Others	19 (2.1)	16 (4.2)	0.03

SAPS II = Simplified Acute Physiology Score II; SOFA = Sequential Organ Failure Assessment; HIV = Human Immunodeficiency Virus; RRT = renal replacement therapy; NYHA III-IV = New York Heart Association class III-IV.

The results show that abdominal infections are associated with significant mortality rates and that concomitant infections are frequent. Microbiology patterns and antibiotic treatments were diverse in this group of patients, and

pathogens were different in patients who had been in the ICU for a longer period of time than in those more recently admitted. The severity of disease and presence of comorbidities determined outcome in these patients.

Table 4 Multivariable analysis with ICU mortality as the dependent variable

	Odds ratio	(95% CI)	p-value
Hematological cancer	4.04	(1.47-11.11)	<0.01
Mechanical ventilation	2.97	(2.03-4.35)	<0.001
Cirrhosis	2.35	(1.29-4.30)	<0.01
RRT (hemodialysis or hemofiltration)	1.51	(1.03-2.21)	0.04
SAPS II score on the study day (per point)	1.06	(1.05-1.07)	<0.001

Legend. Adjusted for hospital, organizational factors and for geographic region. CI = confidence interval; SAPS II = Simplified Acute Physiology Score II; RRT = renal replacement therapy. Hosmer-Lemeshow goodness of fit: $\chi^2 = 5.315$ with 8 df, p-value = 0.723; the c-statistic 0.82 (95%CI:0.80-0.85), p-value < 0.0001.

Mortality in patients who had abdominal infections was significantly higher than in patients who had other infections (most of which were respiratory infections), which was not found in previous studies. In an analysis of patients from the Sepsis Occurrence in Acutely Ill Patients (SOAP) study, Volakli et al. reported no differences in mortality rates among patients with abdominal infections and those with respiratory infections [6]. The higher mortality rate in patients with abdominal infections in our study may be explained by a number of differences between abdominal and other infections. First, timely source control is particularly important in the management of abdominal infections [22], and the method by which source control is obtained may influence outcomes [23]. Failed source control is often difficult to identify and can be a cause of persistent infection. In addition, abdominal infections are typically polymicrobial and often associated with resistant organisms; in the current study, non-survivors more frequently had *P. aeruginosa* and *Stenotrophomonas maltophilia* as pathogens. Finally, the large number of concomitant infections may also have affected outcomes.

As expected, comorbidities, such as cirrhosis and hematological cancer, were associated with increased mortality, as was found in the EPIC II patients in general [1]. Most notably, the impact of cirrhosis was considerable with a 2.3-fold increase in the risk of death. A recent analysis of the Project Impact database also showed that cirrhosis was independently associated with an increased risk of 30-day mortality [24].

The microbiology patterns were diverse, and quite different from those in the overall EPIC II study population, in which staphylococci were isolated most frequently, and Gram-positive and Gram-negative organisms were equally present [1]. In the patients with abdominal infections, the picture was substantially different: Gram-negative bacteria were isolated almost twice as frequently as Gram-positive bacteria, with *E. coli* being the most prevalent pathogen; typical nosocomial microorganisms, such as *P. aeruginosa*

and *Enterobacter* spp. were also frequently isolated. Indeed, *P. aeruginosa* was the second most frequently isolated Gram-negative microorganism, which may in part be due to the design of the study, but the percentages are comparable to other studies in this field [25]. Among the Gram-positive microorganisms, enterococci were most prevalent, whereas staphylococci were uncommon. Furthermore, there were important differences in microbiology between survivors and non-survivors, with *P. aeruginosa* and *Stenotrophomonas maltophilia* isolated twice and four times more often, respectively, in non-survivors than in survivors. These pathogens may have a greater degree of pathogenicity (although *Stenotrophomonas* is generally not considered to be a major pathogen), or may be more difficult to treat. Detailed data regarding antibiotic resistance, including information regarding resistance to specific antibiotics, were not collected so we are unable to comment further on these aspects.

The findings in this study suggest that physicians around the world seem to comply with international guidelines in this field as most patients receive broad-spectrum antibiotics, often in combination with agents aimed at fungi or even at resistant Gram-positive microorganisms. We also found that patients who had stayed in the ICU for 2 days or less on the study day had different characteristics to those who had been longer on the ICU. Microbiological isolates and antibiotic treatments were remarkably different between these groups with fewer carbapenems, glycopeptides and antifungals used in patients with shorter stays. Current guidelines for the selection of antibiotic therapy in critically ill patients do not mention length of stay in the hospital as a consideration for empirical treatment in patients with high-severity non-nosocomial infections. Nevertheless, this group represents a category of patients, presumably with community-acquired infection, who could potentially be treated with narrower spectrum antibiotics when local ecology allows. This hypothesis warrants further evaluation.

Fungal infections have received considerable attention in the last decade. Although the debate continues as to whether fungi are relevant in community-acquired disease, the situation is different in nosocomial infections and in severely ill patients [20]. *Candida* isolation has been identified as an independent predictor of mortality in some studies [19,26,27], which has triggered widespread use of empiric antifungal coverage with fluconazole in this setting. In the current study, fungi were isolated in approximately 1 in 6 patients, but antifungal therapy was administered to almost 30% of the patients, reflecting the high use of antifungal prophylaxis in this group. Fungi were found more often in patients who had been in the ICU for more than 2 days, but were not linked to mortality in the current study. Identifying which patients are at risk of fungal infection and may

Table 5 Microbiology and antibiotic use in patients who had been admitted for 2 days or less vs. more than 2 days on the study day

	LOS ≤2d (n = 492)	LOS >2d (n = 899)	P
Microorganisms: Positive isolates	260 (53)	669 (74.4)	<0.001
Gram-positive bacteria			
Methicillin-sensitive <i>S aureus</i>	10 (3.8)	11 (1.6)	0.04
Methicillin-resistant <i>Staphylococcus aureus</i>	7 (2.7)	27 (4)	0.33
Methicillin-sensitive coagulase-negative staphylococci	4 (1.5)	23 (3.4)	0.12
Methicillin-resistant coagulase-negative staphylococci	5 (1.9)	20 (3.0)	0.37
Enterococci, ampicillin-sensitive	22 (8.5)	100 (14.9)	<0.01
Group A, B, C, G <i>Streptococcus</i>	4 (1.5)	10 (1.5)	0.96
<i>Streptococcus pneumoniae</i>	1 (0.4)	4 (0.6)	0.69
<i>Streptococcus</i> , other than group A, B, C and D	11 (4.2)	20 (3)	0.34
Gram-positive cocci, other	2 (0.8)	6 (0.9)	0.85
Gram-positive bacilli, other	2 (0.8)	6 (0.9)	0.85
Enterococci, ampicillin-resistant	23 (8.8)	47 (7.0)	0.35
Gram-negative bacteria			
<i>Escherichia coli</i>	74 (28.5)	137 (20.5)	<0.01
<i>Enterobacter</i> spp.	22 (8.5)	55 (8.2)	0.91
<i>Klebsiella</i> spp.	21 (8.1)	64 (9.6)	0.48
<i>Proteus</i> spp.	13 (5.0)	34 (5.1)	0.96
<i>Salmonella</i> spp.	2 (0.8)	5 (0.7)	0.97
<i>Serratia</i> spp.	2 (0.8)	3 (0.4)	0.55
<i>Citrobacter</i> spp.	1 (0.4)	12 (1.8)	0.10
<i>Pseudomonas aeruginosa</i>	17 (6.5)	69 (10.3)	0.08
<i>Pseudomonas</i> , other than <i>P aeruginosa</i>	0 (0.0)	4 (0.6)	0.21
<i>Stenotrophomonas maltophilia</i>	5 (1.9)	12 (1.8)	0.90
<i>Acinetobacter</i> spp.	8 (3.1)	27 (4)	0.49
<i>Campylobacter</i> spp.	4 (1.5)	3 (0.4)	0.09
<i>Haemophilus</i> spp.	0 (0.0)	2 (0.3)	0.38
Enterobacteria, other	4 (1.5)	5 (0.7)	0.27
<i>Bacillus</i>	3 (1.2)	10 (1.5)	0.69
Anaerobes			
<i>Clostridium</i>	21 (8.1)	72 (10.8)	0.22
Anaerobic cocci	2 (0.8)	5 (0.7)	0.97
<i>Bacteroides</i>	9 (3.5)	20 (3.0)	0.71
Anaerobes, other	9 (3.5)	6 (0.9)	<0.01
Mycobacteria	1 (0.4)	1 (0.1)	0.49

Table 5 Microbiology and antibiotic use in patients who had been admitted for 2 days or less vs. more than 2 days on the study day (Continued)

Fungi			
<i>Candida albicans</i>	29 (11.2)	89 (13.3)	0.38
<i>Candida non-albicans</i>	6 (2.3)	32 (4.8)	0.09
<i>Aspergillus</i>	0 (0.0)	2 (0.3)	0.38
Fungi, other	1 (0.4)	4 (0.6)	0.69
Antibiotic use			
Cephalosporins	115 (23.4)	145 (16.1)	<0.001
Penicillins	191 (38.9)	290 (32.3)	0.01
Other beta lactams	116 (23.6)	331 (36.8)	<0.001
Aminoglycosides	64 (13.0)	114 (12.7)	0.85
Quinolones	67 (13.6)	131 (14.6)	0.64
Glycopeptides	78 (15.9)	252 (28)	<0.001
Macrolides	7 (1.4)	23 (2.6)	0.17
Other antibiotics	194 (39.5)	355 (39.5)	0.99
Antifungals	80 (16.3)	266 (29.6)	<0.001

benefit from preemptive antifungal therapy remains a challenge; length of stay in the hospital and other risk factors for fungal infection, such as upper gastrointestinal tract perforation and previous antibiotic exposure [28], should be considered before initiating antifungal therapy. The prevalence of *Candida non-albicans* isolates was lower than frequently reported in invasive candidiasis studies or other studies in patients with *Candida* peritonitis. For example, Montravers et al. reported that only 58% of patients with *Candida* peritonitis had *C. albicans* isolated from intraoperative cultures [18]. In patients with invasive candidiasis, a systematic review by Andes et al. indicated that just 44% of the isolates were *C. albicans* [29]; patients with *Candida* peritonitis accounted for only 1% of the patients in this review, however. It is not clear whether the infecting *Candida* species or its susceptibility plays a major role in determining outcome [18].

This study has a number of limitations. Because the study was not primarily focused on abdominal infections, the exact source and extent of infection were not recorded and the efficacy of source control and appropriateness of antimicrobial therapy could not be evaluated. The rate of superinfection and/or tertiary peritonitis could not be assessed. Data on the community-acquired versus nosocomial nature of infections were also not available and we, therefore, used the length of stay as a surrogate marker, but acknowledge that this has its limitations. Finally, as in all point-prevalence studies, patients who are admitted for a long period of time may skew the findings with more data collected on those who stay in the ICU for a longer period of time.

Conclusion

In conclusion, this study found that abdominal infections were present in about one fifth of ICU patients on the study day and concomitant infections were common. Microbiology patterns and choice of antibiotic therapy were diverse and differed in patients who had stayed in the ICU for 2 days or less compared to those with longer stays. Abdominal infections carry a poor prognosis, with higher mortality rates than in patients with infections from other sources. Disease severity, need for organ support and presence of comorbidities were independently associated with mortality in our cohort.

Appendix: List of participating centers by country, alphabetically

Andorra: Hospital Nostra Senyora de Meritxell (A Margarit); *Argentina*: Centro de Educación Médica E Investigaciones Clínicas (R Valentini); Clínica de Especialidades Villa Maria (AJ Zazu); Clínica Modelo de Morón (C Bevilacqua); Clínica Y Maternidad Suizo (M Curone); CMIC (R Rabuffetti); Hospital Aleman (P Comignani); Hospital Argerich (M Torres Boden); Hospital Británico (F Chertcoff); Hospital Central de San Isidro (G Cardonatti); Hospital de Niños Dr. Héctor Quintana (F Adén); Hospital del Niño Jesús (L Marcos); Hospital Dr Pedro Ecay (M Dónofrio); Hospital Español de Mendoza (R Fernández); Hospital Español Medical Plaza (R Lamberghini); Hospital Internacional General de Agudos "José de San Matín" (S Balasini); Hospital Interzonal Dr. O. Alende (J Teves); Hospital Italiano de Buenos Aires (M Las Heras, J Sinner); Hospital Juan A. Fernández (D Ceraso); Hospital Municipal de Chivilcoy (D Curcio); Hospital Profesor Alejandro Posadas (L Aguilar); Hospital Provincial de Rosario (C Weller); Hospital Provincial del Centenario (L Cardonnet); Hospital Regional Rio Gallegos (R Santa Cruz); Hospital Regional Ushuaia (E Manrique); Hospital Universitario Austral (D Bernardez, T Iolster); Hospital Universitario Universidad Abierta Interamericana (G Chiappero); Instituto Privado del Quemado Med-Inter (D Curcio); Nuevo Hospital El Milagro (P Ramos); Ramos Mejia Hospital (J Vergara); Sanatorio Agote (I Moine); Sanatorio de la Trinidad Mitre (S Ilutovich); Sanatorio de Los Arcos (G Jannello); Sanatorio Dupuytren (M Waschbusch); Sanatorio Frangioli de Salud 2000 Srl (G Rios Picaza); Sanatorio Mater Dei (A Raimondi); Sanatorio Otamendi Y Miroli (M Miriam); Sanatorio Parque (L Carlos); Sanatorio San José (D Curcio); *Armenia*: Centro Gallego de Buenos Aires (M Caridi); *Australia*: Alfred Hospital (T Leong); Barwon Health (N Orford); Blacktown Hospital (G Reece); Box Hill Hospital (D Ernest); Cabrini Hospital (F Hawker); Concord Repatriation General Hospital (J Tan); Epworth Eastern Private Hospital (C Giannellis); Epworth Hospital Richmond (B Ihle); Flinders Medical Centre (A Bersten);

Frankston Hospital (J McInnes); Gold Coast Hospital (M Tallott); John Hunter Hospital (B Mcfadyen); Joondalup Health Campus (J Vibert); Liverpool Hospital, Sydney South West Area Health Service (M Parr); Logan Hospital (K Tran); Mater Health Services (J Sutton); Mount Hospital (S Webb); Nambour General Hospital (N Groves); Nepean Hospital, NSW (L Cole); Prince Charles Hospital (D Long); Prince of Wales Hospital (F Bass); Princess Margaret Hospital For Children (S Erickson); Royal Brisbane and Womens' Hospital (J Lipman); Royal Children's Hospital, Brisbane (D Long); Royal Children's Hospital, Melbourne (C Delzoppo); Royal Darwin Hospital (J Thomas); Royal Perth Hospital (G Dobb); Royal Prince Alfred Hospital (M Daley); Sir Charles Gairdner Hospital (B Roberts); St John of God Hospital, Subiaco (S Webb); St Vincent's Hospital, Melbourne (J Santamaria); Sydney Children's Hospital (J Young); The Children's Hospital at Westmead, Sydney (M Festa); The John Flynn Private Hospital (R Holland); The Prince Charles Hospital (D Mullany); The Queen Elizabeth Hospital (P Williams); The Townsville Hospital (M Corkeron); The Wollongong Hospital (M Gales); Westmead Hospital (A Banerjee); Women's and Children's Hospital, Adelaide (M Yung); *Austria*: University Hospital Innsbruck (N Mutz, M Hiesmayr); General Hospital (P Faybik); Hospital Hietzing (R Fitzgerald); Krankenhaus Barmherzige Brüder Linz (F Firlinger); Krankenhaus Der Barmherigen Brueder Wien (G Zasmeta); Krankenhaus Der Barmherzigen Brüder St. Veit (M Zink); Krankenhaus Der Barmherzigen Schwestern Linz (W Sieber); Krankenhaus Steyr (J Hildegard); Landeskrankenhaus Klagenfurt (R Bakondy); Landeskrankenhaus Stolzalpe (J Schlieber); Landeskrankenhaus Deutschlandsberg (G Filzwieser); Medical University Innsbruck (R Beer, M Joannidis); Medical University of Vienna (T Staudinger); Otto-Wagner Hospital (R Schuster); Unfallkrankenhaus Meidling Der Auva (W Scherzer); University Hospital (K Smolle); Wilhelminenspital (S Fitzal); *Bangladesh*: Central Hospital Limited (R Manzoor); *Belgium*: A.I.T. (J Brunain); Ambroise Paré (A Dive); Asz-Aalst (G Huylenbroeck); Az Groeninge Kortrijk (M Van der Schueren); Az Maria Middelaes (H 't kindt); Az Sint Jozef Malle (E Slock); Az Sint Lucas (D Rijckaert); Az St Augustinus (J Raemaekers); Az St Jan Av (M Bourgeois); Az Vesalius (I Van Cotthem); Az Damiaan Oostende (G Nackaerts); C.H.N.D.R.F. (D Gusu); Centre Hospitalier de Mouscron (P Gadisseeux); CH Libramont (V Olivier); Chirec - Braine-L'Alleud (H Lignian); CHPLT Verviers (P Michel); CHR Citadelle (V Fraipont); CHR Haute Senne Soignies (M Van der Stappen); CHR St Joseph Mons-Warquignies (F Forêt); CHU Brugmann (D De Bels, J Devriendt, J Massaut); CHU Charleroi (P Biston); CHU Saint-Pierre (A Roman); CHU Sart Tilman, Liège (B Lambermont); Clinique Sainte Elisabeth (A De Meulder); Clinique Notre Dame (V Frederic); Clinique Notre-Dame de

Grâce (T Sottiaux); Clinique Saint Luc, Bouge (P Ruyffelaere); Cliniques de L'Europe, St-Michel (V Collin); Cliniques de L'Europe, Ste Elisabeth (S Anane); Hôpital Français (P Kleiren); Hôpital Saint-Joseph (M Simon); Hornu (S Machayekhi); Imeldaziekenhuis (E Frans); Institut Jules Bordet (G Leroy, T Berghmans); Jan Yperman Hospital (R Joseph); Olv Ter Linden Ziekenhuis, Knokke (J Eerens); Saint Luc University Hospital (PF Laterre); Sint Augustinus, Veurne (B Lagrou); St Vincent (R Rutsaert); St-Jozefkliniek Bornem-Willebroek (W Pisarek); UCL Mont-Godinne (A Dive); Universitair Ziekenhuis Gent (J De Waele); University Hospital Brussels (H Spaepen); University Hospital of Liege (P Damas); Erasme University Hospital (JL Vincent); ZNA Stuivenberg (M Malbrain); *Belize*: Universal Health Services, Medical Center (J Hidalgo); *Brazil*: Bandeirantes Hospital (M Baptista); Barra Dor Hospital (D Salgado); Biocor Instituto (M Braga); Casa de Saude Sao Jose Caxias (C Avila); Centro Hospitalar Unimed (G Westphal); Centro Integrado de Atenção À Saúde -Unimed Vitória (E Caser); Clínica São Vicente da Gávea (A Alves); Complexo Hospitalar Santa Casa de Porto Alegre (G Friedman); Erasto Gaertner Hospital (M Luz); Federal University of Sao Paulo (M Assuncao); Fundacao Hospital de Clinicas Gaspar Vianna (H Reis); Fundação Hospitalar Do Estado de Minas Gerais - Fhemig (A Gomes); Fundação Pio Xii (U Silva); UNIFESP (W Nogueira Fh); Hospital das Clínicas - FMUSP (S El-Dash); Hospital Padre Albino-Faculdade de Medicina de Catanduva (J Valiatti); Hospital Alberto Cavalcanti (A Barbosa); Hospital Badim (C Coelho); Hospital Cardiotrauma Ipanema (M Knibel); Hospital Carlos Fernando Malzoni (C Minelli); Hospital Da Cidade de Passo Fundo (J Caovilla); Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo (G Teixeira); Hospital das Clínicas, University of São Paulo (A Hovnanian); Hospital das Nacoes (A Rea-Neto); Hospital de Base-Famerp (SL Lobo); Hospital de Clínicas Mario Lioni (M Lugarinho); Hospital de Clínicas Niterói (P Souza); Hospital de Doenças Tropicais de Goiânia (D Ferreira); Hospital do Cancer/Uopecan (P Duarte); Hospital do Trabalhador (M Oliveira); Hospital dos Servidores do Estado Rio de Janeiro (J Marques); Hospital E Maternidade São José (R Machado); Hospital Estadual Diadema (P Rehder); Hospital Estadual do Grajau-Unisa (S Mataloun); Hospital Evangelico (M Grilo); Hospital Evangelico do Rio de Janeiro (P Quesado); Hospital Geral de Pedreira (M Moock); Hospital Geral de São Mateus (F Ferreira); Hospital Geral Roberto Santos (J Teles); Hospital Israelita Albert Einstein (E Silva); Hospital Israelita Albert Sabin (C Coelho); Hospital Júlia Kubitschek (A Moraes); Hospital Mater Dei (F Carvalho); Hospital Memorial Arthur Ramos (M Wanderley); Hospital Meridional (M Velasco); Hospital Moinhos de Vento (N Brandão da Silva); Hospital

Municipal São José (J Feijó); Hospital Nossa Senhora Da Salette (P Duarte); Hospital Pasteur (V Souza Dantas); Hospital Português (J Teles); Hospital Pró-Cardíaco (R Costa Filho); Hospital Quinta D'Or (A Japiassu); Hospital Regional Antônio Dias (D Villela); Hospital Regional de Barbacena (C Santos); Hospital Salvador (R Passos); Hospital Samaritano (R Alheira-Rocha); Hospital Santa Izabel (R Silva); Hospital Santa Paula (J Houly); Hospital Sao Cristovao (J Aldrighi); Hospital São Lucas (R Hatum); Hospital São Lucas da PUCRS (F Suparregui Dias); Hospital São Luiz - Unidade Itaim (L Ferreira); Hospital São Rafael (L Ferro); Hospital São Vicente de Paulo (J Gomez); Hospital Universitário Clementino Fraga Filho - Ufrj (R Fleury); Hospital Universitario da Universidade Federal do Rio de Janeiro (C David); Hospital Universitário de Santa Maria (T Resener); Hospital Universitário do Oeste do Paraná (P Duarte); Hospital Universitário Lauro Wanderley - UTI Adulto (C Mendes); Hospital Universitario Regional de Maringa (A Germano); Hospital Vita Curitiba (M Oliveira); Hospital Vivalle (F De marco); Instituto de Espquisa Clinica Evandro Chagas (A Japiassu); Instituto Do Coração - HC-FMUSP (S Lage); Instituto Nacional de Cancer (J Salluh); Irmandade Santa Casa de Misericordia de Porto Alegre (A Torelly); Luxemburgo Hospital (R Sad); Mternidade Odete Valadares (A Barbosa); Prontocor Lagoa (G Oliveira); Samaritano Hospital (R Lima); Santa Casa Da Misericórdia de São João del Rei (J Paranhos); Santa Casa de Misericordia de Passos (M Oliveira); Santa Casa de Porto Alegre (M Rocha); São Sebastião Hospital (W Bitencourt); Universidade Federal Do Parana (A Rea-Neto); University of Londrina (C Grion); University of Sao Paulo (D Forte); Uti Da Disciplina de Clínica Médica-Unifesp (H Guimarães); Vitória Apart Hospital (C Piras); *Bulgaria*: Mbal Ruse (L Stephanova); Multiprofile Hospital of Active Treatment, Ruse (L Lyubenov); Uh St. Ekaterina (G Tsarianski); Univerisity Hospital (G Dimov); *Canada*: Capital Health-Queen Elizabeth II Health Sciences Centre (R Green); Centre Hospitalier Régional de Lanaudière (J Levasseur); Children's Hospital of Eastern Ontario (R Ward); CHU Sherbrooke (O Lesur); Hôpital Charles Lemoyne (G Poirier); Mount Sinai Hospital (R Wax); Royal Jubilee Hospital (G Wood); St. Joseph's Healthcare (D Cook); St. Michael's Hospital (J Marshall); Toronto General Hospital (M Herridge); Toronto Western Hospital (N Ferguson); Victoria General Hospital (G Wood); *Chile*: Clinica Alemana de Santiago (M Espinoza); Clinica las Condes (S Valdés jimenez); Hospital Clínico de la Pontificia Universidad Católica de Chile (A Bruhn); Hospital del Trabajador (J Micolich); Hospital Dr G. Fricke (S Galvez); Hospital El Pino (I Escamilla Leon); *China*: Beijing Chaoyang Hospital (Q Zhan); Beijing Tongren Hospital (Y Xu); Chinense Pla General Hospital (Y Zhao); Fuxing Hospital, Capital Medical University (L Zhang);

Guangdong Provincial People's Hospital (T Qin); Peking Union Medical College Hospital (B Du); Peking University People's Hospital (M Li); Ren Ji Hospital, Shanghai Jiao Tong University (X Wang); The Affiliated Hospital of Ningxia Medical College of China (Y Jing); The First Affiliated Hospital of China Medical University (Z Zhang); The First Affiliated Hospital of Dalian Medical University (W Xianyao); The First People's Hospital of Nantong, Jiangsu (F Li); Zhong-Da Hospital and School of Clinical Medicine, Southeast University (Y Congshan); *Colombia*: Clinica General del Norte (C Rebolledo); Clinica Central del Quindio (D Diaz); Clinica Medellin (R Murillo Arboleda); Clinica Saludcoop (C Rebolledo); Clinica Santa Isabel de Valledupar. (A Arias Antun); Fundación Hospital San Carlos (G Montenegro); Fundacion Valle del Lili (M Granados); Hospital Bocagrande de Cartagena (C Duenas); Hospital Departamental de Villavicencio (N Perez); Hospital El Tunal (G Libreros Duque); Hospital San Jose de Bogota (M Coral); Hospital Santa Clara (G Ortiz); *Costa Rica*: Hospital Calderón Guardia CCSS (D Rodriguez); *Croatia*: Hospital for Infectious Diseases (B Barsic); Sveti Duh General Hospital, School of Medicine, Zagreb (M Cubrilo-Turek); University Hospital Centre (I Gornik); University Hospital Zagreb (M Grljusic); *Cuba*: Hospital Universitario Arnaldo Milian Castro (A Caballero lopez); Hospital Universitario Dr. Gustavo Aldereguía Lima (M Iraola ferrer); *Czech Republic*: Centre of Cardivascular and Transplant Surgery (P Pavlik); Charles University Teaching Hospital, Hradec Kralove (J Manak); Charles University Medical School and Teaching Hospital (J Radej); Faculty General Hospital, Charles University Prague (J Belohlavek); Faculty Hospital Brno (P Sevcik); Faculty Hospital Olomouc (L Blahut); General Teaching Hospital of 1st Faculty and Charles University (D Tyl); Horovice Hospital (J Steinbach); Klaudians Hospital (I Herold); Krajska Nemocnice Liberec (I Zykova); Nemocnice V Usti Nad Orlici (D Prchal); St. Anne's University Hospital Brno (T Bartosik); University Hospital Brno (M Kolarova); University Hospital Olomouc (R Hájek, J Kohoutová, O Marek); University Hospital Ostrava (P Hon); University Hospital Plzen (I Chytra); *Denmark*: Århus University Hospital (H Betsch); Næstved Hospital (B Fogh); Rigshospitalet (K Espersen); Sygehus Fyn (K Jacobsen); Vejle Sygehus (P Berezowicz); *Ecuador*: Carlos Andrade Marín Hospital (F Guerrero); Clinica La Merced (E Salgado); Hospital Eugenio Espejo (D Barahona); Hospital General de Las Fuerzas Armadas del Ecuador Hg-1 (H Del pozo sanchez); Hospital Metropolitano (M Jibaja); *Egypt*: Dar Alfouad Hospital (A Alansary); *Estonia*: East Tallinn Central Hospital (A Reintam); Tartu University Hospital (J Starkopf); *Finland*: Helsinki University Central Hospital (V Harjola); *France*: AP-HP, CHU Jean Verdier (L Tual); Assistance Publique-Hôpitaux de Marseille, CHU Nord (M Leone); Centre Hospitalier Dunkerque

(M Serge); Centre Hospitalier Universitaire (P Michel); Centre Hospitalier (O Leroy); Centre Hospitalier D'Auch (L Mallet); Centre Hospitalier de Blois (B Marc); Centre Hospitalier de Fougères (D Dormoy); Centre Hospitalier de Niort (H Pascal); Centre Hospitalier Dr Schaffner (L Tronchon); Centre Hospitalier du Pays D'Aix (B Garrigues); Centre Hospitalier Region Annecy (C Santré); Centre Hospitalier Universitaire Amiens (H Dupont); Centre Hospitalier Universitaire de Bicêtre (J Duranteau); Centre Hospitalier Universitaire Reims (A Leon); CH Colmar (L Henry); CHG Armentieres (C Canevet); CHU Angers (L Dube); CHU Angers (H Julien); CHU Bicetre (A Nadia); CHU Brest (B Francois); CHU de Bordeaux (J Gérard); CHU Dijon Hopital Général (M Freysz); CHU Hôtel Dieu - APHP (G Remy); CHU Nantes (Y Blanloeil); Clinique Ambroise Paré (P Squara); General Hospital (J Korach); Grenoble University Hospital (M Durand); Groupe Hospitalier du Havre (C Gabriel); Hia Laveran (P Eric); Hopital Antoine Béchère APHP (F Jacobs); Hopital Bichat (R Bronchard); Hôpital Claude Huriez, Centre Hospitalier Régional Universitaire de Lille (E Kipnis); Hopital Cochin Paris (M Moussa); Hôpital de Hautepierre (A Launoy); Hopital de la Croix Rousse (C Guérin); Hôpital Edouard Herriot (P Vanhems); Hôpital Maison Blanche (A Wynckel); Hôpital Raymond Poincaré (B Clair); Hôpital Saint-Louis (E Azoulay); Hôpital Tenon (J Fulgencio); Hôpitaux Civils de Colmar (Y Gottwalles); Hôpitaux Universitaires de Strasbourg (T Krummel); Hospices Civils de Lyon (A Lepape); La Rochelle Hospital (O Lesieur); Lariboisiere University Hospital (D Payen); Poissy Hospital (O Hervé); Polyclinique Saint André (J Farkas); Rangueil Hospital (P Cougot); Réanimation Chirurgicale (Y Malledant); University Hospital of Bordeaux Haut-Lévêque (O Joannes-Boyau); *Germany*: Academic Hospital Solingen (T Standl); Ameos Klinikum St.Salvator Halberstadt GMBH (U Sierig); Asklepios Fachkliniken München-Gauting (J Geiseler); Asklepios Klinik Langen (H Hopf); Behandlungszentrum Vogtareuth (M Burgau); Bergmannsheil Bochum (E Conrad-Opel); Bethanien-Krankenhaus (C Hermann); Bundeswehrkrankenhaus Ulm (M Ventzke); Charite/Campus Virchow-Klinikum (T Henneberg); Charite Berlin-Buch (H Loeser); Charité Campus, Mitte (C Spies); Charité Campus, Virchow Klinikum (C Spies); Charite Campus, Virchow (F Esposito); Charité Universitätsmedizin Berlin (H Zuckermann-becker); Clemenshospitl (R Scherer); Dominikus Krankenhaus (A Pauer); Drk-Kliniken Mark Brandenburg (S Kljucar); Drk-Krankenhaus Ratzeburg (K Delfs); Elisabeth-Krankenhaus Essen (E Blank); Ev. Kliniken Bonn Betriebsstätte Waldkrankenhaus (J Busch); Ev.-Freikirchliches Krankenhaus Rüdersdorf (K Wendt); Evang. Krankenhaus Mülheim (J Leßmann); Evangelische Kliniken Bonn Wadkrankenhaus (J Busch); Evangelisches Krankenhaus Bielefeld (F Bach); Friedrich Schiller University,

Jena (Y Sakr); Gemeinschaftskrankenhaus Herdecke (T Berlet); Georg-August University of Göttingen (A Kernchen); Georg-August-University of Göttingen (M Quintel); Hanse-Klinikum Wismar (D Holst); Heart clinic of the University of Munich (E Kilger); Helfenstein Klinik (T Holubarsch); Helios Klinik Lengerich (C Raufhake); Helios-Klinikum Berlin-Buch (R, Kuhlen, C Stolt); Helios Klinikum Emil Von Behring (A Lubasch); Helios Klinikum Erfurt GmbH (A Meier-Hellmann); Helios Klinikum Wuppertal Barmen (G Woebker); Henriettenstift (C Scharnoffske); Herz-Jesu-Krankenhaus (M Breyer); Hochtaunus Kliniken Bad Homburg (T Risch); Hospital Links Der Weser (C Manhold); Icu In Drk Kliniken Mark Brandenburg (S Kljucar); J.W. Goethe - University Medical School Frankfurt Am Main (D Meininger); Johanniter Krankenhaus Bonn (C Greive); Johanniter Krankenhaus Stendal Ggmbh (J Rau); Jung-Stilling-Krankenhaus (A Seibel); Katharinenhospital (A Henn-beilharz); Katholisches Krankenhaus Hagen (R Wolbert); Krankenhaus Prignitz Gemeinnützige GMBH (T Scherke); Klinik Am Eichert (J Martin); Klinik Für Herzchirurgie (M Rudolph); Klinik Füranästhesie, Operative Intensivmedizin U. Schmerztherapie (J Gleißner); Kliniken Ludwigsburg-Bietigheim GMBH (M Wolf); Kliniken Maria Hilf (F Schleibach); Klinikum Augsburg (U Jaschinski); Klinikum Bad Salzungen (A Lunkeit); Klinikum Darmstadt (M Welte); Klinikum Der J.W. Goethe-Universität (T Bingold); Klinikum Der Stadt Wolfsburg (K. Sydow); Klinikum Emden (K Kogelmann); Klinikum Forchheim (F Fischer); Klinikum Fuerth (B Fischer, M Schmid); Klinikum Grosshadern, Universität München (M Klein); Klinikum Harlaching Städtisches Klinikum Muenchen (A Bechtold); Klinikum Hildesheim (K Bodmann); Klinikum Kaufbeuren (J Klasen); Klinikum Landsberg (H Meyrl); Klinikum Lippe - Detmold (J Goetz); Klinikum Ludwigsburg (G Geldner); Klinikum Luedenscheid (T Helmes); Klinikum Meiningen GMBH (N Jensen); Klinikum Minden (H Eickmeyer, W Lengfelder); Klinikum Nürnberg (B Langenstein); Klinikum Rechts Der Isar (R Bogdanski); Klinikum Rechts Der Isar Der Technischen Universität München (S Jelen-Esselborn, A Umgelter); Klinikum Region Hannover (F Dörr); Klinikum Region Hannover Krankenhaus Großburgwedel (K Lüttje); Klinikum Region Hannover, Krankenhaus Oststadt-Heidehaus (D Heinemeyer); Klinikum Starnberg (M Uhl); Klinikum Stuttgart - Olgahospital (P Schirle); Klinikum Suedstadt (H Benad); Klinikum Traunstein (M Glaser); Klinikum Uelzen (W Panzer); Klinikum Worms (E Huettemann); Klinikverbund St. Ansgar, Krankenhaus Bassum (R Stierwaldt); Klinikverbund Süd-West (M Schappacher); Knappschaftskrankenhaus Bochum-Langendreer (E Müller); Krankenhaus Freyung (Rural Hospital) (W Stadlmeyer); Krankenhaus Lübbecke (M Fantini); Krankenhaus Mol GMBH Strausberg (B

Dummer); Krankenhaus Nordwest (M Thörner); Krankenhaus Nordwest (V Jost); Krankenhaus Reinbek (T Loerbroks); Kreisklinik Trostberg (T Glück); Kreiskrankenhaus Bergstrasse (R Zimmermann); Kreiskrankenhaus Calw (R Clement); Kreiskrankenhaus Mechernich GMBH (R Hering); Kreiskrankenhaus Nagold (T Klinger); Kreiskrankenhaus Rottweil (J Mehl); Kreiskrankenhaus St. Marienberg Helmstedt (H Polozek); Leopoldina-Krankenhaus (A Rothhammer); Ludmillenstift (R Seidler); Lukas-Krankenhaus Bünde (P Lorenz); Lungenfachklinik Amsee Waren Mueritz (M Lutze); Marienhospital Bruehl (M Euler); Marienkrankenhaus Schwerte (M Heintz); Martin Luther Universität Halle (M Winkler); Medizinische Klinik (M Angstwurm); Mlu Halle-Wittenberg (K Krohe); Mueritz-Klinikum Waren (T Treu); Neurological Intensive Care Unit (T Steiner); Oberschwabenklinik Wangen (S Locher); Orthopädische Klinik Markgröningen (A Walz); Ostalb-Klinikum Aalen (P Zahn); Otto-Von-Guericke Universität Magdeburg (W Brandt); Scivias-Krankenhaus St. Josef (M Marks); Ska-Bielefeld-Mitte (F Henning); St. Antonius Hospital (U Janssens); St. Hildegardis Krankenhaus Mainz (M Luethgens); St. Johannes Krankenhaus (W Theelen); St. Johannes-Hospital (M Sydow); St. Johannes-Hospital (M Weber); St. Josef-Hospital, Ruhr-Universität Bochum (A Meiser); St. Josefs-Hospital (C Deutschmann); St. Joseph Krankenhaus (C Buttner); St.-Marien Hospital Lünen (M Jokiel); St. Marienhospital Hamm (C Bozzetti); St. Vincentius Kliniken (B Jürgen); St.-Elisabeth Krankenhaus Köln-Hohenlind (F Fiedler); St.-Vincentius-Krankenhaus Speyer (K Wresch); Städtischen Kliniken Neuss - Lukaskrankenhaus (A Kremer); Städtisches Klinikum Karlsruhe (H Bleier); Städtisches Klinikum Wiesbaden, Dr.-Horst-Schmidt-Kliniken Hsk (M Rueckert); Staedtsches Klinikum Guetersloh (H Ditter); Staedtsches Klinikum Muenchen GmbH - Klinikum Harlaching (C Peckelsen); Staedtsches Klinikum Muenchen GmbH/Klinikum Bogenhausen (P Friederich); Staedtsches Klinikum München - Klinikum Neuperlach (K Weber); Tübingen University Hospital (W Krueger); Ubbo-Emmius-Klinik Aurich (R Lowack); Überlingen Hospital (A Michalsen); Uniklinikum Dresden (M Ragaller); Universitaetsklinikum des Saarlandes (A Groeschel); Universitaetsklinikum Mannheim (T Friedrich, U Hoffmann); Universität Rostock (M Hinz); Universitätsklinikum Der Martin-Luther-Universität Halle-Wittenberg (A Christel); Universitätsklinikum Dresden Carl Gustav Carus (M Ragaller); Universitätsklinikum Leipzig AöR (T Hartwig); Universitätsmedizin Berlin Charité Campus Benjamin Franklin (S Vögeler); University (M Weiss); University Childrens Hospital Hauner (K Reiter); University Hospital (T Schwab); University Hospital Cologne (U Trieschmann); University Hospital Dusseldorf (D Kindgen-milles); University Hospital Giessen and Marburg GmbH - Giessen (J Engel); University Hospital Lübeck (B Sedemund-

adib); University Hospital Mainz (M Lauterbach); University Hospital Marburg (M Max); University Hospital Muenster (T Volkert); University Hospital of Essen (C Waydhas); University Hospital of Mannheim (S Hien); University Hospital of Munich, LMU (J Briegel); University Hospital of Regensburg (V Guralnik); University Hospital Rwth Aachen (N Zoremba); University Hospital Tübingen (R Riessen); University Hospital Würzburg (W Müllges); University Medical Center Hamburg-Eppendorf (A Nierhaus); University of Erlangen (R Strauss); University of Freiburg (S Utzolino); University of Giessen (J Thul); University of Greifswald (P Abel, M Gründling, W Keßler); University of Heidelberg (K Scheuren); University of Leipzig (E Lothar, U Kaisers, D Schmitt, D Schneider); University of Rostock (D Vagts); University of Saarland (H Rensing); University Hospital Essen (B Schoch); University Hospital (K Kopp); Vivantes - Klinikum Neukoelln (H Gerlach); Vivantes Klinikum Prenzlauer Berg (M Corea); Vivantes-Klinikum Am Urban (A Uhrig); Westküstenklinikum Heide (S Schroeder); Westküstenklinikum Heide (F Jordan); Westpfalz-Klinikum Kaiserslautern (T Huber); Zentralölklinikum Augsburg (M Bittinger) *Greece*: Ahpa University Hospital (E Sofianos); Athens University Medical School (A Armaganidis); Evangelismos Hospital (C Routsis); G.Papanikolaou (M Bitzani); General Hospital of Rethymno (A Chalkiadaki); Henry Dunant Hospital (A Michalopoulos); Hippokrateion Hospital Thessaloniki (E Mouloudi); Kat General Hospital (E Ioannidou); Kat Hospital (P Myrianthes); Kat Hospital, Athens (D Koulenti); Konstantopoulou General Hospital (I Karampela); Lamia General Hospital (G Kyriazopoulos); Red Cross Hospital of Athens (K Mandragos); Thriassio Hospital of Eleusis (P Clouvalmolyvdas); University Hospital of Ioannina (A Moraiti); University Hospital of Alexandroupolis (I Pneumatikos); University Hospital of Rion, Patras (K Filas); University Hospital of Thessaly (Larissa) (E Zakynthinos); University of Athens, Medical School (A Kotanidou); Xanthi General Hospital (A Vakalos) *Hong Kong*: Northern District Hospital (A Cheng); Princess Margaret Hospital and Yan Chai Hospital (T Buckley); The Chinese University of Hong Kong (C Gomersall) *Hungary*: National Institute of Neurosurgery (K Kiss); Péterfy Hospital Budapest (P Tamási); Saint George Hospital Hungary (A Sarkany); Semmelweis University (A Csomos); University of Szeged (É Zöllei) *India*: Advanced Medicare Research Institute (S Todi); B.D.Petit Parsee General Hospital (F Udawadia); Bhailal Amin General Hospital (R Shah); Bombay Hospital (P Amin); Breach Candy Hospital Trust (F Udawadia); Care Hospitals (S Samavedam); Christian Medical College (A Mathai); Cumballa Hill Hospital & Heart Institute (M Patil); Deenanath Mangeshkar Hospital (S Jog); Dr. S. N. Medical College (M Gurjar); Escorts Heart Institute & Research Centre (M

Vats); Fortis Healthcare (A Varma); Global Hospitals (P Gopal); Hinduja Hospital & Medical Research Center (F Kapadia); Indraprastha Apollo Hospitals (R Chawla); Jehangir Hospital (S Iyer); Kalinga Hospital (S Sahu); Kasturba Hospital (C Bakshi); Lokmanya Care Hospital (D Ambike); Max Super Speciality Hospital (D Govil); Medical Trust Hospital, Cochin (V Kariparambath); Nh Hospital (J Chacko); Ruby Hall Clinic (P Sathe); Rungta Hospital (N Rungta); Saifee Hospital (C Jani); Seth Ramdas Shah Memorial Hospital & Research Centre (A Bhome); Shree Medical Foundation (S Prayag); Sir Ganga Ram Hospital (S Ray); Sundaram Medical Foundation (R Rajagopalan); Tata Memorial Hospital (J Divatia); Wockhardt Hospital (R Da costa); Wockhardt Hospital (T Shyam Sunder) *Indonesia*: Bintaro International Hospital (P Wibowo); Hasan Sadikin Hospital (T Maskoen); Pantai Indah Kapuk Hospital (T Sugiman) *Islamic Republic of Iran*: Imamreza Hospital (S Nowruzinia); Laleh Hospital (A Lotfi); Tehran University of Medical Sciences (A Mahmoodpoor) *Ireland*: Amnch (M Donnelly); Cork University Hospital (D Breen); Mater Misericordiae University Hospital (S Ng); University Hospital Galway (J Bates) *Israel*: Hadassah Medical Center (C Sprung); Haemek Medical Center (A Lev); Kaplan Medical Center (E Kishinevsky); Rabin Medical Center (J Cohen); Soroka Medical Center (S Sofer) *Italy*: A.O Niguarda (S Vesconi); A.O. Ospedale Di Circolo Di Busto Arsizio (S Greco); A.O. Treviglio-Caravaggio (M Borelli); Anestesia E Rianimazione 2 Prof.De Gaudio (P Cecilia); Arnas Ospedale Civico (M Sapuppo); ASL 10 (A Lazzero); ASL 10 Florence Hospital San Giovanni Di Dio (V Mangani); Azienda Ospedaliera Desenzano (N Petrucci); Azienda Ospedaliera Di Melegnano (M Minerva); Azienda Ospedaliera G. Rummo (E De Blasio); Azienda Ospedaliera Polo Universitario San Paolo (S Marzorati); Azienda Ospedaliera Santa Maria Alle Scotte (R Rosi); Azienda Ospedaliera Universitaria P.Giaccone Policlinico (A Giarratano); Azienda Ospedaliera-Universitaria Udine (O Margarit); Azienda Ospedaliero -Universitaria (A Guberti); Azienda Ospedaliero-Universitaria S.M.Misericordia (S Scolz); Clinica San Gaudenzio (E Stelian); Fondazione IRCCS Policlinico San Matteo (V Emmi); Fondazione Ospedale Maggiore Policlinico, Mangiagalli Regina Elena (M Caspani); Fondazione Poliambulanza (A Rosano); H San Gerardo (C Abbruzzese); Hospital Panico Tricase (S Colonna); Humanitas Gavazzeni (R Ceriani); II Faculty of Medicine I University of Rome- Osp. S.Andrea (R De Blasi); S. Salvatore Hospital (L Panella); IRCCS Casa Sollievo Della Sofferenza (F Borrelli); Istituto Nazionale Tumori Regina Elena (P Lorella); KH Brixen (H Ruatti); Osepdali Riuniti Di Ancona (C Munch); Ospedale "Ca Foncello" - Treviso (Italia) (C Sorbara); Ospedale "Santa Croce" - ASL 8 (G Fiore); Ospedale Bufalini-Cesena (A Chieragato); Ospedale Di Circolo E Fondazione Macchi (V Conti); Ospedale Di

Massa (A Guadagnucci); Azienda USL Piacenza (M Pizzamiglio); Ospedale Ferrarotto (M Locicero); Ospedale Maggiore Ausl Bologna (I Marri); Ospedale Maggiore Policlinico Milano (A Sicignano); Ospedale Maggiore Policlinico, Mangiagalli E Regina Elena, IRCCS Milano (V Conte); Ospedale Mugello Azienda Sanitaria Firenze (R Oggioni); Ospedale Niguarda Ca Granda, Milano (A De Gasperi); IRCCS Centro di Riferimento Oncologico della Basilicata (P De Negri); Ospedale Provinciale Pistoia (G Santagostino); Ospedale S. Gerardo (R Fumagalli); Ospedale San Raffaele (G Marino); Ospedale Vittorio Emanuele (G Castiglione); P.O. San Severo Asl Fg (D Sforza); S. Camillo Hospital (N Giuseppe); San Martino Hospital (M Bassetti); Seconda Università Degli Studi Di Napoli (F Ferraro); Sesto San Giovanni Hospital (S Clementi); Teaching Hospital Careggi (D Alessandro); Terapia Intensiva - Aso S. Giovanni Battista Di Torino - Ospedale Molinette (P Cotogni, MV Ranieri); Università Cattolica (M Antonelli); Università Cattolica Del S. Cuore (L Martinelli); University-Hospital Careggi, Florence, (L Giancesello); University Hospital Policlinico Di Catania (A Gullo); University of Rome "La Sapienza" (A Morelli); UTI Trapianti (G Biancofiore); University of Udine (G Della Rocca) *Japan*: Kyoto Prefectural University of Medicine (S Hashimoto); Nagoya University Hospital (M Onodera); Oosaka-Fu Saiseikai Suita Hospital (A Kobayashi); Sanaï Hospital (T Shinozuka); Tokushima University School of Medicine (H Imanaka); Tokyo Medical University, Hachioji Medical Center (T Ikeda); Tokyo Women's Medical University (A Yaguchi) *Latvia*: Hospital of Traumatology and Orthopedics (I Misane); 7th Hospital of Riga (A Piebalga) *Lebanon*: Lebanese Canadian Hospital (A Moughaghab) *Lithuania*: Medicine University of Kaunas (V Pilvinis); Vilnius University Emergency Hospital (S Vosylius); Vilnius University Hospital Santariskiu Clinics (M Balciunas, G Kekstas) *Luxembourg*: Centre Hospitalier de Luxembourg (H Margaret); Clinique Ste Thérèse (M Klop) *Macedonia*: Clinic For Infectious Diseases (K Grozdanovski); General Hospital Stip (B Eftimova) *Malaysia*: Faculty of Medicine, Universiti Kebangsaan Malaysia (S Wafa); Hospital Pulau Pinang (C Lim); Hospital Tengku Ampuan Afzan, Kuantan, Pahang (M Mat nor); Kuala Lumpur Hospital (L Tai); National Heart Institute (S Syed Mohd Tahir); Sarawak General Hospital (N Idris); Sultanah Aminah Hospital (C Tan) *Malta*: St Luke's Hospital (M Borg); *Mexico*: Angeles Metropolitan Hospital (E Manzo); Centro Medico Lic. Adolfo Lopez Mateos (H Gutierrez Morales); Hgr 25 Imss Zaragoza (P Miguel); Hospital Angeles Clinica Londres (A Villagomez); Hospital Angeles del Carmen (A Bassols); Hospital Civil de Guadalajara "Fray Antonio Alcalde" (G Aguirre); Hospital Español de México (U Cerón); Hospital General Bernardo J. Gastelum (J Lopez ramos); Hospital General del Estado "Dr Ernesto Ramos Bours", Hermosillo Sonora Mexico (J Monjardín); Hospital General Regional de Leon (E Bermudez Aceves); Hospital General Reynosa (F Gonzalez Salazar); Hospital Juan I. Menchaca Hospital Civil de Guadalajara (D Rodriguez Gonzalez); Hospital Juárez de México (M Poblano-Morales); Hospital Médica Sur (F Ramirez); Hospital O'horan (M Cetina); Hospital Privado de Hermosillo (J Navarro); Hospital Regional 1° Octubre, Issste (A Villagomez Ortiz); Hospital San Jose Tec Monterrey (V Sanchez); Hospital Universitario "Dr. Jose E. Gonzalez" (U Chavarria); IMSS (O Fernandez-Ponce); Iner (H Serna secundino); Instituto de Salud del Estado de Aguascalientes (O Leonardo); Instituto Mexicano del Seguro Social (R Diego Manuel, J Mijangos); Issemym Medical Center (G Vazquez de Anda); Mexican Red Cross (E Martin); Ocq Hospital (P Gutierrez); Secretaria de Salud del Gobierno del Distrito Federal (I López Islas); Servicios de Salud En Yucatan (L Soberanes) *Montenegro*: Clinical Center of Montenegro (P Ljubica) *Morocco*: Chu Ibn Sina (A Sbihi); Polyclinique CNSS Derb Ghalleg (B Ouahid); Réanimation Médicale, Hôpital Ibn Sina (M Naoufel) *Netherlands*: Academic Medical Center (A De Pont); Amphia Hospital (P Rosseel); Antoni Van Leeuwenhoek Ziekenhuis (J Ten Cate); Beatrix Zienhuis Rivas Zorggroep (G Van Berkel); Canisius Wilhelmina Ziekenhuis (S Corsten); Erasmus Mc University Medical Center (J Bakker); Hagaziekenhuis (J Vogelaar); Hofpoort Hospital Woerden (H Blom); Isala Clinics (H Kieft); Medical Center Leeuwarden (M Kuiper); Medisch Spectrum Twente (A Gille); Radboud University Nijmegen Medical Centre (P Pickkers); Rode Kruis Ziekenhuis (J Vet); Slingeland Ziekenhuis (J Ammann); Spaarneziekenhuis (S Den Boer); St. Antonius Ziekenhuis (R Wesseling); St. Elisabeth Hospital (B Speelberg); Twenteborg Hospital Almelo (C Pham); University Medical Center, Groningen (M Rodgers); University Hospital Maastricht (D Bergmans); Vu University Medical Center (J Groeneveld) *New Zealand*: Auckland City Hospital (C McArthur); Auckland City Hospital (R Parke); Christchurch (J Mehrstens); Dunedin Hospital (L Celi); Hawke's Bay Hospital (R Freebairn); Middlemore Hospital (N Rankin); Nelson Marlborough District Health Board (C Heffernan); Palmerston North Hospital (G McHugh); Starship Children's Hospital (J Beca); Waikato Hospital (F Van Haren); Wellington Public Hospital (B Barry); Whangarei Base Hospital (M Kalkoff) *Norway*: Aker University Hospital (R Loevestad); St Olavs University Hospital (P Klepstad); Sykehuset Asker Og Bærum Hf (P Erno); Sykehuset I Vestfold Hf , Toensberg (A Junker) *Pakistan*: Armed Forces Institute of Cardiology (S Naqvi); Jinnah Hospital Lahore Pakistan (I Javed) *Panama*: Complejo Hospitalario Metropolitano (J Sinclair) *Peru*: Hipolito Unanue Hospital (R Rivera); Hospital Regional Honorio Delgado (C Chavez); Hospital Alberto Sabogal Sologuren (Z Donayre Taber); Hospital

Dos De Mayo (R Quispe Sierra); Hospital Edgardo Rebagliati Martins (J Muñoz); Hospital Maria Auxiliadora (J Galvez Ruiz); Hospital Nacional Almanzor Aguinaga Asenjo Essalud Chiclayo (J Fang Li); Hospital Nacional Arzobispo Loayza (M Candiotti Herrera); Hospital Víctor Lazarte Echegaray (A Arroyo); Instituto de Salud del Niño (R Becerra); Navy Hospital (J Meza); Peruvian Air Force Central Hospital (M Mayorga) *Poland*: 4th Military Clinical Hospital (P Garba); Academic Centre for Maritime and Tropical Medicine AMG (J Kot); Barlicki University Hospital, University of Medical Science, Lodz, (T Gaszynski); Boleslaw Szarecki Teaching Hospital No. 5 of The Medical University In Lodz (M Piechota); Clinical Hospital No 2 (S Renata); Collegium Medicum Jagiellonian University (P Müller); Institute of Cardiology (J Stepinska); J. Brudzinski's Hospital In Gdynia (K Jacek); Jagiellonian University (T Cieniawa); Karol Marcinkowski University of Medical Sciences (A Mikstacki, B Tamowicz); Poznan University of Medical Sciences (A Bartkowska-Sniatkowska); Silesian University of Medicine (E Karpel); University Hospital Bydgoszcz Cm Umk (K Kusza); University Hospital No 2 (P Smuszkiewicz); University Hospital Warsaw (M Mikaszewska-Sokolewicz); Wojewodzki Szpital Specjalistyczny (R Goraj); Wroclaw Medical University (A Kubler) *Portugal*: Centro Hospitalar Alto Ave (A Bártolo); Centro Hospitalar Cova Da Beira (M Castelo-Branco Sousa); Centro Hospitalar Trás os Montes e Alto Douro (F Esteves); CHLO-Hospital S Francisco Xavier (A Martins); H S João (T Oliveira); Hospital CUF Infante Santo (P Ponce); Hospital Curry Cabral (L Mourão); Hospital da Luz (C Febra); Hospital de Egas Moniz (E Carmo); Hospital de S. José (V Lopes); Hospital de São Francisco Xavier (P Póvoa); Hospital de São José (A Rezende); Hospital Divino Espirito Santo (H Costa); Hospital do Litoral Alentejano (P Moreira); Hospital Dr. José Maria Grande, Portalegre (F Pádua); Hospital Fernando Fonseca (A Leite); Hospital Garcia de Orta (E Almeida); Hospital Geral de Santo António (M Alves); Hospital de Pulido Valente (A Sousa, L Telo); Hospital de S. João (C Dias, J Paiva); Hospital de São Bernardo (R Ribeiro); Hospital de São Sebastião, EPE (P Amaro); Hospital Geral de Sto António (A Carneiro); Hospital de St. António dos Capuchos (R Moreno, Ricardo Matos, Susana Afonso); Instituto Português de Oncologia de Lisboa (M Bouw); Hospital de St Maria (C França) *Qatar*: Alkhor Hospital (A Ibrahim); Romania: "Maria Sklodowska Curie" Children's Emergency Hospital, Bucharest (R Tabacaru); Department Public Hospital (V Ionita); Fundeni Institute (D Tulbure); Institute of Cardiovascular Disease (D Filipescu); Institutul de Boli Cardiovasculare Si Transplant Tg. Mures (S Pascanu); Spitalul "Sf. Spiridon" (I Grigoros); University Emergency County Hospital (S Copotoiu) *Russia*: Bakoulev Scientific Center For Cardiovascular Surgery (D Popov); City Clinical Hospital (E Lebedev); City

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Additional file

Additional file 1: Table S1. Sites of infection. **Table S2.** Antibiotic use in patients with abdominal infections. **Table S3.** Microbiology and antibiotic use in survivors and non-survivors.

Abbreviations

ICU: Intensive care unit; EPIC: Extended Prevalence of Infection in the ICU; SAPS: Simplified acute physiology score; SOFA: Sequential organ failure assessment; ISF: International Sepsis Forum; SD: Standard deviation; IQR: Interquartile range; LOS: Length of stay; SOAP: SEPSIS Occurrence in Acutely Ill Patients.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

JLV, JL, YS and JM designed the study, JLV and JDW analyzed the data and drafted the manuscript, JL, YS, JM, PV, CBG, ML revised it critically for important intellectual content. All authors read and approved the final manuscript.

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References

- Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, Moreno R, Lipman J, Gomersall C, Sakr Y, Reinhart K, Investigators EIGO: **International study of the prevalence and outcomes of infection in intensive care units.** *JAMA* 2009, **302**:2323–2329.
- Vincent JL, Bihari DJ, Suter PM, Bruining HA, White J, Nicolas-Chanoine MH, Wolff M, Spencer RC, Hemmer M: **The prevalence of nosocomial infection in intensive care units in Europe. Results of the European Prevalence of Infection in Intensive Care (EPIC) Study.** EPIC International Advisory Committee. *JAMA* 1995, **274**:639–644.
- Finfer S, Bellomo R, Lipman J, French C, Dobb G, Myburgh J: **Adult-population incidence of severe sepsis in Australian and New Zealand intensive care units.** *Intensive Care Med* 2004, **30**:589–596.
- Ranieri VM, Thompson BT, Barie PS, Dhainaut JF, Douglas IS, Finfer S, Gardlund B, Marshall JC, Rhodes A, Artigas A, Payen D, Tenhunen J, Al-Khalidi HR, Thompson V, Janes J, Macias WL, Vangerow B, Williams MD: **Drotrecogin alfa (activated) in adults with septic shock.** *N Engl J Med* 2012, **366**:2055–2064.
- Vincent JL, Sakr Y, Sprung CL, Ranieri VM, Reinhart K, Gerlach H, Moreno R, Carlet J, Le Gall JR, Payen D: **Sepsis in European intensive care units: results of the SOAP study.** *Crit Care Med* 2006, **34**:344–353.
- Volakli E, Spies C, Michalopoulos A, Groeneveld AB, Sakr Y, Vincent JL: **Infections of respiratory or abdominal origin in ICU patients: what are the differences?** *Crit Care* 2010, **14**:R32.
- Pieracci FM, Barie PS: **Intra-abdominal infections.** *Curr Opin Crit Care* 2007, **13**:440–449.
- Marshall JC: **Intra-abdominal infections.** *Microbes Infect* 2004, **6**:1015–1025.
- Marshall JC, al Naqbi A: **Principles of source control in the management of sepsis.** *Crit Care Clin* 2009, **25**:753–768. viii.
- Seifert H, Dalhoff A: **German multicentre survey of the antibiotic susceptibility of Bacteroides fragilis group and Prevotella species isolated from intra-abdominal infections: results from the PRISMA study.** *J Antimicrob Chemother* 2010, **65**:2405–2410.
- Nicoletti G, Nicolosi D, Rossolini GM, Stefani S: **Intra-abdominal infections: etiology, epidemiology, microbiological diagnosis and antibiotic resistance.** *J Chemother* 2009, **21**(Suppl 1):5–11.
- Dupont H: **The empiric treatment of nosocomial intra-abdominal infections.** *Int J Infect Dis* 2007, **11**(Suppl 1):S1–S6.
- Seguin P, Laviolle B, Chanavaz C, Donnio PY, Gautier-Lerestif AL, Campion JP, Malledant Y: **Factors associated with multidrug-resistant bacteria in secondary peritonitis: impact on antibiotic therapy.** *Clin Microbiol Infect* 2006, **12**:980–985.
- Cainzos M: **Review of the guidelines for complicated skin and soft tissue infections and intra-abdominal infections—are they applicable today?** *Clin Microbiol Infect* 2008, **14**(Suppl 6):9–18.
- Barie PS, Hydo LJ, Eachempati SR: **Longitudinal outcomes of intra-abdominal infection complicated by critical illness.** *Surg Infect (Larchmt)* 2004, **5**:365–373.
- Bodmann KF, Expertenkommission I: **Complicated intra-abdominal infections: pathogens, resistance.** *Chirurg* 2010, **81**:38–49.
- Dupont H, Friggeri A, Touzeau J, Airapetian N, Tinturier F, Lobjoie E, Lorne E, Hijazi M, Regimbeau JM, Mahjoub Y: **Enterococci increase the morbidity and mortality associated with severe intra-abdominal infections in elderly patients hospitalized in the intensive care unit.** *J Antimicrob Chemother* 2011, **66**:2379–2385.
- Montravers P, Mira JP, Gangneux JP, Leroy O, Lortholary O: **A multicentre study of antifungal strategies and outcome of Candida spp. peritonitis in intensive-care units.** *Clin Microbiol Infect* 2011, **17**:1061–1067.
- Montravers P, Dupont H, Gauzit R, Veber B, Auboyer C, Blin P, Hennequin C, Martin C: **Candida as a risk factor for mortality in peritonitis.** *Crit Care Med* 2006, **34**:646–652.
- Solomkin JS, Mazuski JE, Bradley JS, Rodvold KA, Goldstein EJ, Baron EJ, O'Neill PJ, Chow AW, Dellinger EP, Eachempati SR, Gorbach S, Hilfiker M, May AK, Nathens AB, Sawyer RG, Bartlett JG: **Diagnosis and management of complicated intra-abdominal infection in adults and children: guidelines by the Surgical Infection Society and the Infectious Diseases Society of America.** *Clin Infect Dis* 2010, **50**:133–164.
- Calandra T, Cohen J: **The international sepsis forum consensus conference on definitions of infection in the intensive care unit.** *Crit Care Med* 2005, **33**:1538–1548.
- De Waele JJ: **Early source control in sepsis.** *Langenbecks Arch Surg* 2010, **395**:489–494.
- Politano AD, Hranjec T, Rosenberger LH, Sawyer RG, Tache Leon CA: **Differences in morbidity and mortality with percutaneous versus open surgical drainage of postoperative intra-abdominal infections: a review of 686 cases.** *Am Surg* 2011, **77**:862–867.
- Sharma A, Mohan S, Schorr C, Vito K, Milcarek B, Hunter K, Zanotti S: **Impact of liver cirrhosis on outcomes in patients with sepsis/septic shock.** *Chest* 2012, **142**:410A. abstr.
- Montravers P, Lepape A, Dubreuil L, Gauzit R, Pean Y, Benchimol D, Dupont H: **Clinical and microbiological profiles of community-acquired and nosocomial intra-abdominal infections: results of the French prospective, observational EBIIA study.** *J Antimicrob Chemother* 2009, **63**:785–794.
- Carneiro HA, Mavrakas A, Mylonakis E: **Candida peritonitis: an update on the latest research and treatments.** *World J Surg* 2011, **35**:2650–2659.
- Sandven P, Qvist H, Skovlund E, Giercksky KE: **Significance of Candida recovered from intraoperative specimens in patients with intra-abdominal perforations.** *Crit Care Med* 2002, **30**:541–547.

28. Dupont H, Bourichon A, Paugam-Burtz C, Mantz J, Desmonts JM: **Can yeast isolation in peritoneal fluid be predicted in intensive care unit patients with peritonitis?** *Crit Care Med* 2003, **31**:752–757.
29. Andes DR, Safdar N, Baddley JW, Playford G, Reboli AC, Rex JH, Sobel JD, Pappas PG, Kullberg BJ: **Impact of treatment strategy on outcomes in patients with candidemia and other forms of invasive candidiasis: a patient-level quantitative review of randomized trials.** *Clin Infect Dis* 2012, **54**:1110–1122.

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